What is claimed is:

1. An inertial sensor comprising an electrodynamic trap for suspending one or more particles and a readout device for measuring variations in the position or motion of said one or more charged particles when said electrodynamic trap is subjected to acceleration.

2. An inertial sensor as set forth in claim 1 wherein said readout device comprises a light source directed at said one or more charged particles and means for measuring the intensity of light scattered by one or more of said particles.

3. An inertial sensor as set forth in claim 2 wherein said light source includes focusing means for concentrating light on said one or more particles.

4. An inertial sensor as set forth in claim 3 wherein said readout device includes means for measuring the intensity of light scattered from said one or more charged particles.

5. An inertial sensor as set forth in claim 3 wherein said readout device includes a reference source of illumination and means for obtaining an interferometric readout from the combination of said backscattered light and said illumination from said reference source.

6. An inertial sensor as set forth in claim 1 wherein said readout device measures variations in the position or motion of said one or more charged particles by optical interferometry.

7. An inertial sensor as set forth in claim 1 wherein said readout device measures variations in the position or motion of said one or more charged particles by optical leverage.

8. An inertial sensor as set forth in claim 1 wherein said one or more particles are suspended within an electric field and wherein said readout device measures variations in the position or motion of said one or more charged particles by detecting changes in said field.

9. An inertial sensor as set forth in claim 8 wherein said changes in said field result from field absorption by said one or more particles.

10. An inertial sensor as set forth in claim 1 wherein said readout device measures variations in the position or motion of said one or more charged particles by producing data representing an image of said particles and processing said image data.

11. An inertial sensor as set forth in claim 10 wherein said readout device comprises a source of illumination directed toward said one or more particles, means for projecting an image of said particles as illuminated on an image sensing array to produce said data representing said image, means for digitizing said data, and a data processor for processing said image data to produce output data indicative of a measure of said acceleration.

12. An inertial sensor as set forth in claim 10 wherein the motion of said one or more particles is manifested in said image as one or more corresponding streaks

13. An inertial sensor as set forth in claim 10 wherein said readout device includes means directing stroboscopic illumination onto said one or more particles to obtain image data providing timed position information on said one or more particles.

14. An inertial sensor as set forth in claim 1 wherein said electrodynamic trap comprises electrodes to which a time-varying potential are applied to suspend charged particles in stable equilibria.

15. An inertial sensor as set forth in claim 14 wherein said electrodes comprise a ring electrode and at least one additional electrode to which an oscillatory electrical potential is applied.

16. An inertial sensor as set forth in claim 15 wherein said oscillatory electrical potential establishes a quadropole field between said electrodes.

17. An inertial sensor as set forth in claim 16 wherein said quadrupole field elastically constrains said one or more charged particles to a specific location between said electrodes by a substantially linear restoring force.

18. An inertial sensor as set forth in claim 17 wherein said trap further includes means for varying said restoring force.

19. An inertial sensor as set forth in claim 18 wherein said at least one additional electrode comprises a pair of end cap electrodes on opposing sides of said ring.

20. An inertial sensor as set forth in claim 19 wherein said end cap electrodes are hyperboloids.

21. An inertial sensor as set forth in claim 19 wherein said end cap electrodes are spherical.

22. An inertial sensor as set forth in claim 19 wherein said end cap electrodes are ring-shaped.

23. An inertial sensor as set forth in claim 18 wherein said at least one additional electrode comprises a second ring electrode.

24. An inertial sensor as set forth in claim 18 wherein said at least one additional electrode comprises a planar electrode positioned parallel to the plane of and spaced from said ring electrode.

25. An inertial sensor as set forth in claim 17 wherein said electrodynamic trap further includes means for varying the magnitude of said oscillatory electrical potential to vary said restoring force.

26. An inertial sensor as set forth in claim 14 wherein said one or more charged particles are constrained to a specific location between said electrodes by restoring force.

27. An inertial sensor as set forth in claim 26 wherein said trap further includes means for varying said restoring force.

28. An inertial sensor as set forth in claim 27 wherein said readout device measures variations in the position or motion of said one or more charged particles by producing data representing an image of said particles and processing said image data.

29. An inertial sensor as set forth in claim 26 wherein said electrodynamic trap further includes means for varying the average magnitude of said time varying electrical potential to vary said restoring force.

43. An inertial sensor as set forth in claim 14 wherein said electrodes are formed from conductive planar layers separated by insulating layers.

44. An inertial sensor as set forth in claim 14 wherein said electrodes are formed from the conductive layers in a printed circuit board.

30. An inertial sensor as set forth in claim 1 wherein said one or more particles have a known mass and charge at the time said readout device measures said variations.

31. An inertial sensor as set forth in claim 30 wherein said one or more particles are ions.

32. An inertial sensor as set forth in claim 30 wherein said one or more particles are naturally monoisotropic ions.

33. An inertial sensor as set forth in claim 30 wherein said sensor includes means for adding a charge to said one or more particles prior to measuring said variations.

34. An inertial sensor as set forth in claim 33 wherein said one or more particles are conductive spheres.

35. An inertial sensor as set forth in claim 1 wherein said readout means detects displacements in the center of mass of said particle or particles caused by said acceleration.

36. An inertial sensor as set forth in claim 1 wherein said readout means detects an increase in the micromotion of said particle or particles caused by said acceleration.

37. An inertial sensor as set forth in claim 1 wherein said readout means detects variations in the orientation of the asymmetrical orbit occupied by said one or more particles.

38. An inertial sensor as set forth in claim 1 wherein more than one particle are suspended in said trap and wherein said readout means detects variations in the relative positions occupied by different ones of said particles.

39. An inertial sensor as set forth in claim 1 wherein said trap further includes means for damping the motion of said particles within said trap.

40. An inertial sensor as set forth in claim 39 wherein said means for damping includes a fluid medium within which said one or more particles are suspended.

41. An inertial sensor as set forth in claim 39 wherein said means for damping subjects said one or more particles to electrodynamic damping.